A COMPARATIVE STUDY ON CATALYTIC CARBON DIOXIDE HYDROGENATION AND CARBON DIOXIDE METHANATION OVER Pt/SBA-15, NiO, Pt/NiO, Co_3O_4 CATALYSTS

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Abstract

Nowadays, more and more attention of researchers is attracted to the reactions that allow to involve CO_2 in chemical transformations with the purpose of its utilization. In this study, carbon dioxide activation was performed by two heterogeneously catalyzed processes: hydrogenation and methanation. The activities of synthetically obtained 0.5% Pt/SBA-15, NiO, 0.5% Pt/NiO as well as of commercial Co_3O_4 catalysts were studied in continuous flow fixed-bed rector with He and Ar carrier gases at varying reaction temperatures (373K-1073K). Prior to catalytic measurements, all the samples were oxidized for 30 minutes at 573 K with oxygen and reduced with hydrogen at different temperatures (373K-1073K). SBA-15 as a reference measurement, demonstrated low carbon dioxide consumption rates. At the same time, mesoporios NiO was very active. Surprisingly, derivation of NiO with Pt nanoparticles did not provide big effect on NiO catalytic performance, consequently, under established reaction conditions Ni-NiO phase was formed where metallic Ni was active. In addition, 100% carbon oxide selectivity was associated with Pt/SBA-15 as opposing to NiO based catalysts, which were highly methane selective. Concerning methanation reaction, Pt/SBA-15 catalyst was inactive up to 1073K. Nickel oxide based catalysts were active from 673K and demonstrated high CO/H_2 ratios. Impact of Pt nanoparticles on mesoporous NiO activity was also insignificant in this reaction. Commercial Co_3O_4 was subjected to carbon dioxide hydrogenation and methanation reactions under three reduction temperatures: 473K, 573K, 673K and being reduced at 473K, showed the highest conversion values in hydrogenation reaction. All three catalytic systems demonstrated high percentage of methane selectivity. However, they turned out to be inactive in methanation reaction and unwanted high ratios of CO/H_2 were observed.